Transmitter hunting by FM transmitter "fingerprinting" is a little-known but proven and effective approach to tracking down repeater interference and other unidentified transmissions.

Sherlock Investigates: "A Case of (Transmitter) Identity"

BY PAUL SIGNORELLI*, WØRW

Your local repeater is having interference problems. The jammer, of course, never identifies. The club's technical committee suspects the source is a regular user but has no proof. They've tried DFing (direction-finding) the offending station, but have concluded only that it is mobile when the interference occurs, since it is never in the same place twice. What can you do? Sherlock to the rescue!

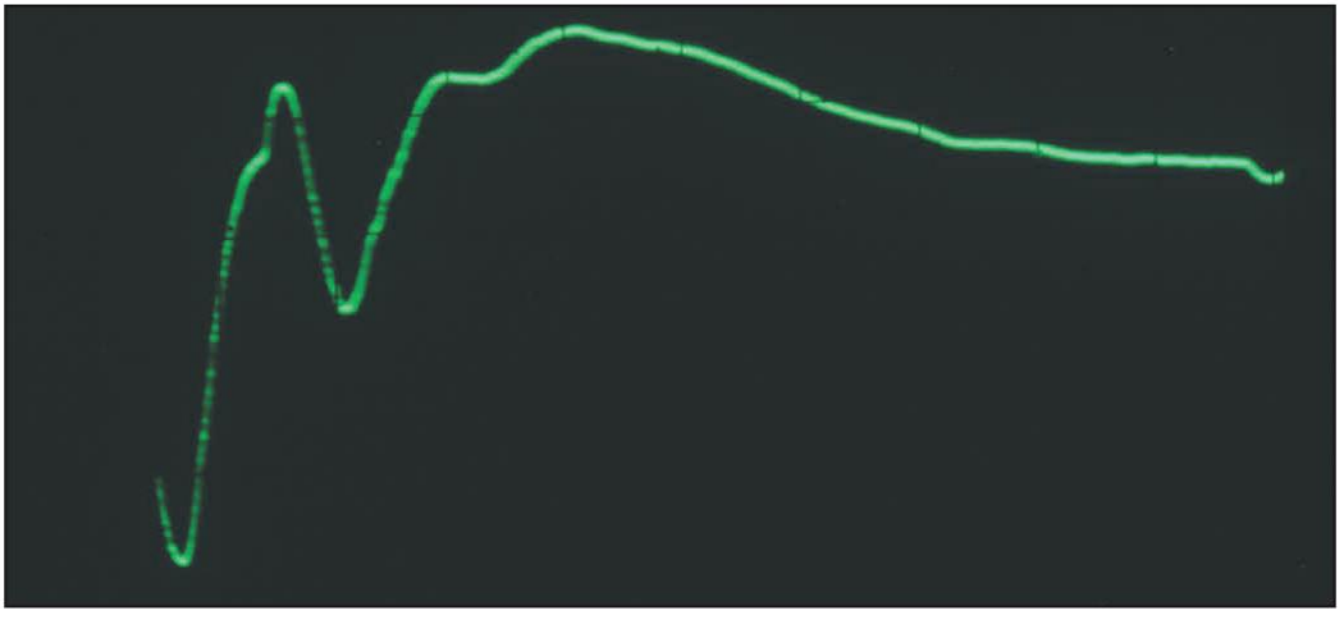
"Elementary," says our fabled sleuth. "Do what all good detectives do … use fingerprints."

Fingerprints? From a radio? You bet. Sherlock explains:

The signals intelligence method of "fingerprinting" an FM radio transmission has been used for a long time and is very simple. Here is how it works:

When an FM transmitter is keyed up, the waveform of the radiated signal varies depending on what type of radio it is. An old crystal-controlled radio will come right up on frequency with little overshoot deviation or drift. Its exact frequency (or offset) will be seen as the displacement from the zero frequency. There are not many of those on the air today.

* email: w0rw1@msn.com>



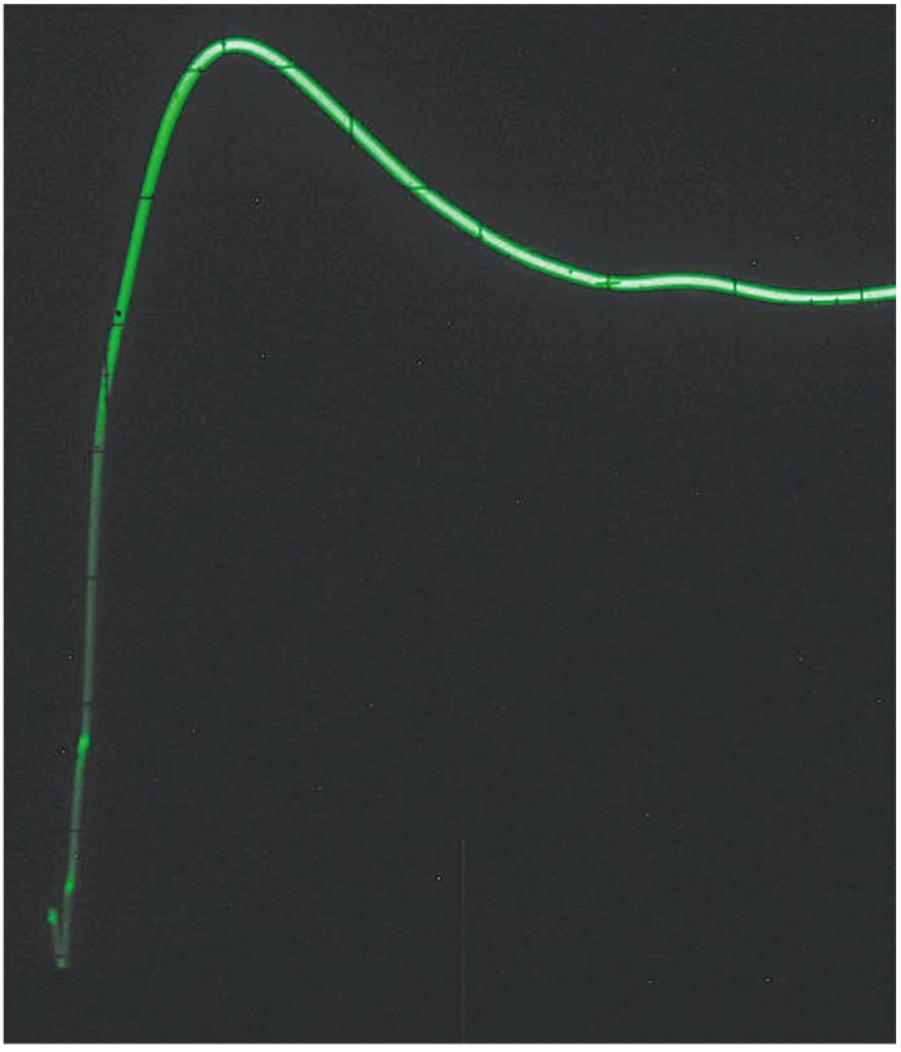
Waveform of wild negative-to-positive oscillations on a transmitter key-up.

A fingerprint receiver consists of an FM receiver and a discriminator pickoff that goes to a DC oscilloscope.

Newer radios use a Phase Locked Loop (PLL) and Voltage Controlled Oscillator (VCO) to generate the transmit frequency, and when they key up, they generate a positive or negative overshoot from the center frequency, sometimes up to 1 kHz. All this takes place within a few milliseconds so you don't usually hear it — but you can *see* it on an oscilloscope set to DC.

Some transmitters are so slow in starting that there is an audible click at the beginning of each transmission. The polarity and amplitude of the overshoot gives you the fingerprint of the transmitter. After the transmitter is on, there can be additional drift depending on the length of the transmission. Of course, if there is also a CTCSS (PL) tone on the carrier, that adds another fingerprint element. A storage oscilloscope is very helpful for recording this data.

A fingerprint receiver consists of an FM receiver and a discriminator pickoff that goes to a DC oscilloscope. Some newer receivers use an FM demodulator chip which won't allow you to have access to the discriminator, but just about any older FM radio will have discriminator access. (For example, pin 4 on the meter socket of an old Motorola radio is the discriminator output.)



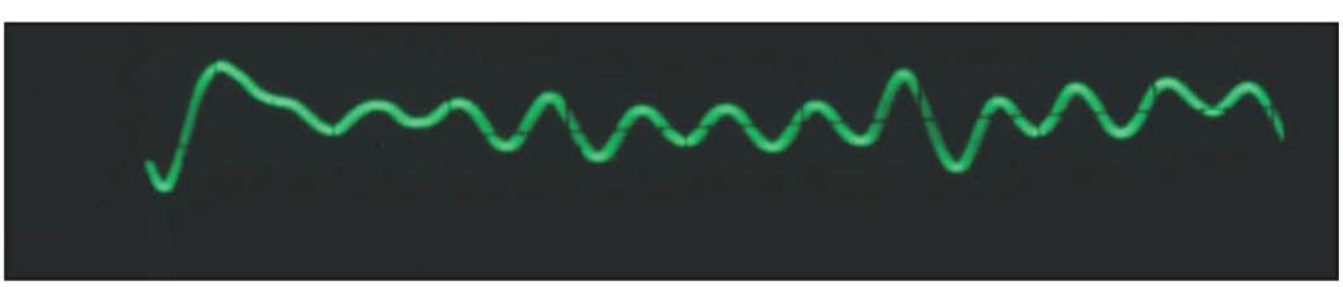
Contrast the previous photo to this one, which shows negative-to-positive overshoot.

A Catalog of Fingerprints

This is an easy way to identify a transmitter and if you collect a catalog of fingerprints of known owners, you can look for a match and find out who owns that transmitter without ever getting out of your shack. As long as the QRM culprit's radio is in your database, you can compare the "fingerprint" of the unidentified transmitter to those in your files and match it up with a known radio's owner. You also can gather the signal strength and see if the station is fixed or mobile. Of course, if you have a beam, you can also get a bearing. At that point, traditional DFing can try to physically locate the source of the transmissions.

I have heard several stories like this, Sherlock concluded: "We had a jammer on one of the local repeaters. We noted how far off frequency he was in his initial overshoot, then watched for him to show up later using his call. Very useful in cleaning up a repeater group."

Sometimes it is a jammer but sometimes it is just a juvenile using Dad's car to go to school and accidentally keying up the transmitter. For more detailed information on this FM fingerprinting technique, see Ellis and Serinken, "Characteristics of radio transmitter fingerprints," in *Radio Science*, July-August 2001. It is available online at <http://bit.ly/2noP1nP>.



This example shows a slight positive overshoot plus CTCSS (PL) riding on the carrier. It is easy to see from these oscilloscope screen shots how every transmitter will have a different "fingerprint" on key-up.

Announcing:

The 2017 CQ World Wide VHF Contest

Starts: 1800 UTC Saturday, July 15, 2017
Ends: 2100 UTC Sunday, July 16, 2017

***NOTE:** Use of APRS by Rovers is now permitted for the purpose of announcing their location.*

I. Contest Period

27 hours for all stations, all categories. Operate any portion of the contest period you wish. (**Note: Exception for QRP Hilltopper**.)

II. Objectives

The objectives of this contest are for amateurs around the world to contact as many amateurs as possible in the contest period, to promote VHF, to allow VHF operators the opportunity to experience the enhanced propagation available at this time of year, and for interested amateurs to collect VHF Maidenhead grid locators for award credits.

III. Bands

All amateur radio frequencies on 50 MHz (6 meters) and 144 MHz (2 meters) may be used as authorized by local law and license class. Note exceptions in Rule XI for common repeater frequencies and 146.52 MHz.

IV. QSO Alerting Assistance

Definition: The use of any technology or other source that provides callsign or multiplier identification along with frequency information about a signal to the operator. This includes, but is not limited to, use of DX Cluster, packet, local, or remote callsign and frequency decoding technology (e.g., CW Skimmer or Reverse Beacon Network), or operating arrangements involving other individuals.

1. All stations are allowed to use QSO Alerting Assistance. **No self-spotting or asking to be spotted is allowed.**

2. Stations attempting digital EME or digital meteor-scatter QSOs are allowed to spot the callsign, **frequency**, **and sequence only**. **Caution**: To ensure strict compliance with these rules, the adjudication process will include review of real-time and archived transcripts from websites used to coordinate alerting data during the contest period.

3. The use of non-amateur means to effect a QSO is not allowed. This includes use of the telephone, and website posts providing information **beyond** that of callsign, frequency, and sequence.

4. Rovers may use APRS to announce their location.

V. Categories of Competition

For all categories: Transmitters and receivers must be located within a 500-meter diameter circle or within the property limits of the station licensee's address, whichever is greater.

1. Single Operator—All Band. Only one signal allowed at any one time; the operator may change bands at any time.

2. Single Operator—Single Band. Only one signal allowed at any one time.

3. Single-Operator All-Band QRP. There are no location restrictions — home or portable — for stations running 10 watts output or less.

4. Hilltopper. This is a single-op QRP **portable** category for an all-band entry limited in time to a **maximum of 6 continuous hours**. Backpackers and portables who do not want to devote resources and time to the full contest period are encouraged to participate, especially to activate rare grids. Any power source is acceptable.

5. Rover. A Rover station is one manned by no more than two operators, travels to more than one grid location, and signs "Rover" or "/R" with no more than one callsign.

6. Multi-Op. A multi-op station is one with two or more operators and may operate 6 and 2 meters simultaneously with only one signal per band.

Stations in any category, except Rover and QRP Hilltopper, may operate from any single location, home, or portable.

VI. Exchange

Callsign and Maidenhead grid locator (4 characters, e.g., EM15). Signal reports are not required and should not be included in the log entry.

VII. Multipliers

The multiplier is the number of different grid locators worked per band. A grid locator is counted once per band. Exception: The rover who moves into a new grid locator may count the same grid locator more than once per band as long as the rover is himself or herself in a new grid locator location. Such change in location must be clearly indicated in the rover's log.

1. A rover station becomes a new QSO to the stations working him or her when that rover changes grid locator.

2. The grid locator is the four-character Maidenhead grid (e.g. EM15).

VIII. Scoring

One (1) point per QSO on 50 MHz and two (2) points per QSO on 144 MHz. Work stations once per band, regardless of mode. Multiply total QSO points times total number of grid locators (GL) worked.

Rovers: For each new grid locator visited, contacts and grid locators count as new. Final Rover score is the sum of contact points made from each grid locator times the sum of all grid locators worked from all grids visited.

Example 1. K1GX works stations as follows:

50 QSOs (50 x 1 = 50) and 25 GLs (25 multipliers) on 50 MHz

35 QSOs (35 x 2 = 70) and 8 GLs (8 multipliers) on 144 MHz

K1GX has 120 QSO points (50 + 70 = 120) x 33 multipliers (25 + 8 = 33) = 3,960 total points.

Example 2. W9FS/R works stations as follows:

From EN52: 50 QSOs (50 x 1 = 50) and 25 GLs (25 multipliers) on 50 MHz

From EN52: 40 QSOs (40 x 2 = 80) and 10 GLs (10 multipliers) on 144 MHz

From EN51: 60 QSOs (60 x 1 = 60) and 30 GLs (30 multipliers) on 50 MHz

From EN51: 20 QSOs (20 x 2 = 40) and 5 GLs (5 multipliers) on 144 MHz

W9FS/R has 230 QSO points (50 + 80 + 60 + 40) x 70 multipliers (25 + 10 + 30 + 5) = 16,100 total points